Space Launch Report: Atlas 5 Data Sheet

Atlas 5

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Atlas 5 Launch Record

Atlas 5 was Lockheed Martin's Evolved Expendable Launch Vehicle (EELV) design for the U.S. Air Force. The United Launch Alliance consortium, a new company spun off by Boeing and Lockheed Martin, took over the Delta IV and Atlas V EELV programs in December 2006.

The rocket, available in several variants, is built around a LOX/RP-1 Common Core Booster (CCB) first stage and a LOX/LH2 Centaur second stage powered by one or two RL10 engines. Up to five solid rocket boosters (SRBs) can augment first stage thrust.

A three-digit designator identifies Atlas V configurations. The first digit signifies the vehicle's payload fairing diameter in meters. The second digit tells the number of SRBs. The third digit provides the number of Centaur second stage RL10 engines (1 or 2).

The Atlas V 400 series, with a 4 meter payload fairing and up to three SRBs, can boost up to 7.7 metric tons to a 28.7 deg geosynchronous transfer orbit (GTO) or 15.26 tonnes to a 28.7 deg low earth orbit (LEO) from Cape Canaveral. Atlas V 500, with a 5 meter diameter payload fairing and up to five SRBs, can put up to 8.9 tonnes to a 28.7 deg GTO or 18.85 tonnes into a 28.7 deg LEO. A 2.5 stage, Atlas 5 Heavy that uses three parallel burn CCBs, has been designed but not developed. Higher payloads to LEO are possible if two RL-10 engines are used, but that variant had not been developed as of mid-2013.

CCB replaces heritage Atlas stainless steel balloon tanks with aluminum isogrid tanks. A single dual thrust chamber RD-180 engine, made by Russia's NPO Energomash, powers the stage. RD-180 was derived from four-chamber RD-170, an engine initially developed for the Soviet's Energia strap on boosters and now used by Zenit launch vehicles. The throttable engine uses a staged combustion cycle, with low pressure turbopumps feeding propellant to a high pressure turbopump. Propellant pressure is further increased through use of a preburner.

At liftoff, CCB thrust can be augmented by up to five Aerojet solid rocket motors (SRBs). At 1.55 x 17.7 meters, the motors are currently the world's largest single-segment solid.

For Atlas V, Centaur, the world's first liquid hydrogen/oxygen upper stage, was stretched and upgraded. The stage still uses stainless steel balloon tanks, with the lower LOX and upper LH2 tanks separated by a common elliptical bulkhead. Centaur is powered by a restartable Pratt & Whitney RL10A-4-2 engine with a fixed carbon-carbon composite nozzle extension.

Thin-skinned Centaur cannot easily support the giant 5.4 meter diameter payload fairing, so the Contraves composite fairing also encloses Centaur. This approach was originally used for Titan 3E and Titan 4. The fairing was derived from Ariane 5 designs.

Atlas 5 launches from Cape Canaveral Space Launch Complex (SLC) 41, a rebuilt Titan 4 pad. At the Cape, Atlas V is assembled in a new 85.4 meter tall Vertical Integration Facility (VIF) and transported 550 meters on a mobile launch platform to the pad no more than 24 hours before liftoff.

On March 13, 2006, AV-006 performed the first West Coast Atlas 5 launch from a rebuilt pad at Vandenberg AFB SLC 3 East. The Vandenberg pad uses a conventional mobile service tower, rather than a "clean pad".

As of mid-2013, ULA had tasked Pratt & Whitney (by then part of the new Aerojet-Rocketdyne company) with converting excess RL10B-2 engines built for Delta IV into RL-10C-1 engines for Atlas V. These engines will dispense with the two extendible nozzle sections, leaving only a single fixed carbon composite exension. The change will result in an engine that produces more thrust than RL10-A-4-2 but that likely produces slightly less specific impulse. Overall, the change will improve Atlas V performance slightly for heavier payloads, but lessen performance for lighter payloads. The modified engines will gradually supplant the original engines, with inventories of both types running out in 2018 or later. At that point, either a new 15 tonne thrust class engine will be developed or new RL10 engines will be purchased.

Atlas 5 Launches NRO Mission

The most powerful Atlas 5 to fly from Vandenberg AFB, a 541 model with four solid rocket motors and a five meter diameter payload fairing, launched the classified National Reconnaissance Office NROL-35 mission on December 13, 2014. The 522 tonne rocket lifted off from Space Launch Complex 3 East at 03:19 UTC and quickly flew into a news blackout.

Analysts expected the launch to orbit a payload bound for an elliptical 12-hour Molniya type orbit. Potential payloads included communications or signals intelligence satellites. The use of an Atlas 541 indicated that the satellite would likely be heavier than any previously launched by the U.S. to a Molniya orbit. A previous launch of a "Trumpet"-type sigint to 1,120 x 37,600 km x 63.56 deg Molniya orbit used a less-capable Atlas 5-411 with only one strap-on solid motor.

The AV-051 Atlas was the first equipped with an RL10C-1 Centaur engine. The Aerojet-Rocketdyne powerplant was a modified RL10B-2 that came from excess stock from the Delta 4 program. To make the conversion, the bottom two extendible nozzle sections of the RL10B-2 were removed and an improved dual direct spark igniter was installed. The engine produced 10.383 tonnes of thrust, a slight improvement from 10.115 tonnes of thrust produced by the previous RL10A-4-2 Centaur engine.

It was the 455th RL10 launched. The engines have flown for 50 years on seven different launch vehicle types, including Saturn I, Atlas Centaur, Atlas 3, Atlas 5, Titan 3E, Titan 4A/B, and Delta 3.

AV-051 was ninth Atlas 5 of the year, a record for Atlas 5. It was also the third Atlas 5 of the year to fly from VAFB.

Vehicle Configurations

	LEO Payload (metric tons) (185 km x 28.5 deg)#	LEO Payload (metric tons) (407 km x 51.6 deg)	LEO Payload (metric tons) (200 km x 28.5 deg) (1) 90.0 deg) (2)	GTO Payload 1500 m/s to GEO* (metric tons)##	GTO Payload 1800 m/s to GEO (metric tons)##	Configuration	LIftoff Height (meters)	Liftoff Mass (metric tons)
Atlas V 401/402	12.5 t			3.765 t	4.95 t	CCB + SEC/DEC + EPF	58.3 m	333.32 t
Atlas V 401 (RL-10C)		8.91 t	9.80 t (1) 8.08 t (2)		4.75 t	CCB + SEC/DEC + EPF	58.3 m	333.32 t
Atlas V 411				4.535 t	6.075 t	CCB + SRB + SEC + EPF	58.3 m	374.12 t
Atlas V 411 (RL-10C)		10.67 t	12.03 t (1) 9.98 t (2)		5.95 t	CCB + SRB + SEC + EPF	58.3 m	374.12 t
Atlas V 421				5.255 t	7.00 t	CCB + 2SRB +SEC + EPF	58.3 m	414.92 t

Atlas V 421 (RL-10C)		12.06 t	13. 60 t (1) 11.14 t (2)		6.89 t	CCB + 2SRB +SEC + EPF	58.3 m	414.92 t
Atlas V 431				5.885 t	7.80 t	CCB + 3SRB +SEC + EPF	58.3 m	461.18 t
Atlas V 431 (RL-10C)		13.25 t	15.26 t (1) 12.13 t (2)		7.70 t	CCB + 3SRB +SEC + EPF	58.3 m	461.18 t
Atlas V 501/502	10.3 t			3.00 t	3.97 t	CCB + SEC/DEC + 5mSPLF	62.2 m	337.29 t
Atlas V 501 (RL-10C)		7.54 t	8.21 t (1) 6.77 t (2)		3.78 t	CCB + SEC/DEC + 5mSPLF	62.2 m	337.29 t
Atlas V 521/522	15.08 t			4.93 t	6.485 t	CCB + SEC/DEC + 2SRB + 5mSPLF	62.2 m	429.81 t
Atlas V 521 (RL-10C)		12.51 t	13.50 t (1) 11.16 t (2)		6.48 t	CCB + SEC/DEC + 2SRB + 5mSPLF	62.2 m	429.81 t
Atlas V 531/532	17.25 t			5.645 t	7.425 t	CCB + SEC/DEC + 3SRB + 5mSPLF	62.2 m	476.07 t
Atlas V 531 (RL-10C)		14.48 t	15.53 t (1) 12.88 t (2)		7.45 t	CCB + SEC/DEC + 3SRB + 5mSPLF	62.2 m	476.07 t
Atlas V 541/542	18.96 t			6.28 t	8.24 t	CCB + SEC/DEC + 4SRB + 5mSPLF	62.2 m	522.33 t
Atlas V 541 (RL-10C)		16.29 t	17.41 t (1) 14.48 t (2)		8.29 t	CCB + SEC/DEC + 4SRB + 5mSPLF	62.2 m	522.33 t
Atlas V 551/552	20.52 t			6.695 t	8.67 t	CCB + SEC/DEC + 5SRB + 5mSPLF	62.2 m	568.59 t
Atlas V 551 (RL-10C)		17.72 t	18.85 t (1) 15.76 t (1)		8.90 t	CCB + SEC/DEC + 5SRB + 5mSPLF	62.2 m	568.59 t

Using Dual Engine Centaur
Using Single Engine Centaur
* GEO: Geosynchronous Earth Orbit
Shaded Models to be Phased Out as RL-10C-1 Enters Service

Vehicle Components

	SRBs (Aerojet)	Common Core Booster (CCB) (Lockheed Martin)	Centaur (Lockheed Martin) Single (SEC)	Centaur (Lockheed Martin)	400 Interstage	500 Interstage

			or Dual (DEC) Engine	Single (SEC) Engine		
Diameter (m)	1.55 m	3.81 m	3.05 m	3.05 m	3.85/3.05 m	3.83 m
Length (m)	17.7 m	32.46 m	12.68 m	12.68 m	4.78 m	4.31 m
Propellant Mass (tons)	42.63 t	284.09 t	20.8 t	20.8 t		
Total Mass (tons)	46.26 t	304.83 t	22.83 t	22.83 t	0.8 t	1.57 t
Engine	AJ-62	RD-180	RL-10A-4-2	RL-10C-1		
Engine Manufacturer	Aerojet	Energomash	Pratt & Whitney	Aerojet Rocketdyne		
Fuel	HTPB	RP-1	LH2	LH2		
Oxidizer	HTPB	LOX	LOX	LOX		
Thrust (sea level, tonnes)	172.2 t	390.2 t				
Thrust (vac (avg) tonnes)	126.98 t	423.4 t	10.12 t	10.383 t		
ISP (sea level, sec)	245 s	311.9 s				
ISP (vac sec)	275 s	338.4 s	450.5 s	~450 s		
Burn Time (sec)	90 s	240 s	926 s (SEC) 463 s (DEC)	~835 s (SEC)		
No. Engines	1	1	1 or 2	1		

Vehicle Components, Cont'd

	400 Large Fairing	400 Extended Fairing	5 m Short Fairing	5 m Long Fairing	
Diameter (meters)	4.2 m	4.2 m	5.4 m	5.4 m	
Length (meters)	12.2 m	13.1 m	20.7 m	23.4 m	
Mass (tons)	2.09 t	2.26 t	4.09 t	4.65 t	

Atlas 5 Launch Record

Date	Vehicle	ID	Payload	Mass kg	Site*	Orbit (kmxkmxdeg)	Orbit Type**
08/21/02	Atlas 5-401	AV001	Hot Bird 6	3905	CC41	315x45863x17.82	GTO+
05/13/03	Atlas 5-401	AV002	HellaSat 2	3440	CC41	312x85457x17	GTO+
07/17/03	Atlas 5-521	AV003	Rainbow 1	4328	CC41	3790x35845x17.5	GTO+
12/17/04	Atlas 5-521	AV005	AMC-16	4200	CC41	4761x34611x27.2	GTO
03/11/05	Atlas 5-431	AV004	Inmarsat 4F1 (4A)	5945	CC41	440x90500x21	GTO+
08/12/05	Atlas 5-401	AV007	MRO Mars Orbiter	2180	CC41		HCO
01/19/06	Atlas 5-551	AV010	Pluto New Horizons	478	CC41		HCO
04/20/06	Atlas 5-411	AV008	Astra 1KR	4332	CC41	6212x37786x23.97	GTO+
03/09/07	Atlas 5-401	AV013	STP-1 (OES+)	1400	CC41	560x560x35.4	LEO
06/15/07	Atlas 5-401	AV009	NROL-30R		CC41	[842x1186x63.35]	[LEO](2)
10/11/07	Atlas 5-421	AV011	WGS-SV1	5770	CC41	477x66847x20.1	GTO+
12/10/07	Atlas 5-401	AV015	NROL-24 (SDS?)		CC41	261x16776x60	EEO/M
03/13/08	Atlas 5-411	AV006	NRO L-28		VA3E	1200x39000x63	EEO/M
04/14/08	Atlas 5-421	AV014	ICO G1	6630	CC41	187x35925x22.7	GTO
04/04/09	Atlas 5-421	AV016	WGS F2	5987	CC41	408x66811x20.93	GTO+
06/18/09	Atlas 5-401	AV020	LRO/LCROSS	2810	CC41	194x353700x28	HTO
09/08/09	Atlas 5-401	AV018	PAN	3000?	CC41		GTO+?
10/18/09	Atlas 5-401	AV017	DMSP-18	1200	VA3E	857kmx99deg	LEO/S
11/23/09	Atlas 5-431	AV024	Intelsat 14	5614	CC41	6037x36823x22.48	GTO+
02/11/10	Atlas 5-401	AV021	SDO	3100	CC41	2498x35318x28.52	GTO
04/22/10	Atlas 5-501	AV012	X-37B OTV-1	4989	CC41	400x400x40	LEO
08/14/10	Atlas 5-531	AV019	AEHF-1	6170	CC41	222x50245x22.2	GTO+

09/21/10	Atlas 5-501	AV025	NROL-41		VA3E	1100x1100x123	LEO/R
03/05/11	Atlas 5-501	AV026	X-37 OTV-2	~5300	CC41		LEO
04/15/11	Atlas 5-401	AV027	NROL-34	~6000?	VA3E	1,000x1,000x63.4	LEO
05/07/11	Atlas 5-401	AV022	SBIRS-GEO 1	4833	CC41	185x35786x21.64	GTO
08/05/11	Atlas 5-551	AV029	Juno	3625	CC41		HCO
11/26/11	Atlas 5-541	AV028	MSL	3839	CC41		HCO
02/24/12	Atlas 5-551	AV030	MUOS 1	6740	CC41	3461x35786x19	GTO
05/04/12	Atlas 5-531	AV031	AEHF-2	6170	CC41	222x50244x20.7	GTO+
06/20/12	Atlas 5-401	AV023	NROL-38		CC41		GTO?
08/32/12	Atlas 5-401	AV032	RBSP A/B	1316	CC41	601x30709x10	EEO
09/13/12	Atlas 5-401	AV033	NROL-36	~6000	VA3E	1000x1000x63.4?	LEO?
12/11/12	Atlas 5-501	AV034	OTV-3(X37B-1F2)	~5000	CC41	343x360x43.5	LEO
01/31/13	Atlas 5-401	AV036	TDRS-K	3454	CC41	4313x35789x25.9	GTO+
02/11/13	Atlas 5-401	AV035	LDCM	2770	VA3E	661x676x98.2	LEO/S
03/19/13	Atlas 5-401	AV037	SBIRS GEO2	~4500	CC41	185x35786x22.19	GTO
05/15/13	Atlas 5-401	AV039	GPS 2F-4	1540	CC41	20200x55	MEO
07/19/13	Atlas 5-551	AV040	MUOS 2	6740	CC41	3802x35787x19.1	GTO
09/18/13	Atlas 5-531	AV041	AEHF 3	6169	CC41	225x50000x20.9	GTO
11/18/13	Atlas 5-401	AV038	MAVEN	2540	CC41		HCO
12/06/13	Atlas 5-501	AV042	NROL 39		VA3E	1100x1100x123	LEO/R
01/24/14	Atlas 5-401	AV043	TDRS-L	3454	CC41	4839x35788x25.5	GTO+
04/03/14	Atlas 5-401	AV044	DMSP F19	1200	VA3E	853x853x98.87	LEO/S
04/10/14	Atlas 5-541	AV045	NROL-67		CC41		GEO?
05/22/14	Atlas 5-401	AV046	NROL-33		CC41		GTO?
08/02/14	Atlas 5-401	AV048	GPS 2F7	1630	CC41	20200x55	MEO
08/13/14	Atlas 5-401	AV047	Worldview 3	2812	VA3E	607x629x97.97	LEO/S
09/17/14	Atlas 5-401	AV049	CLIO		CC41		GTO+
10/29/14	Atlas 5-401	AV050	GPS 2F-8	1630	CC41	20200x55	MEO
12/13/14	Atlas 5-541	AV051	NROL 35		VA3E	2101x37748x62.85	EEO/M(3)
01/21/15	Atlas 5-551	AV052	MUOS 3	6740	CC41	3817x35787x19.11	GTO
03/13/15	Atlas 5-421	AV053	MMS	5440	CC41	580x70279x28.78	EEO
05/20/15	Atlas 5-501	AV054	AFSPC 5 (X37B OTV4?)	5000+	CC41		LEO
07/15/15	Atlas 5-401	AV055	GPS 2F-10	1630	CC41	20200x55	MEO
09/02/15	Atlas 5-551	AV056	MUOS 4	6740	CC41	3819x35786x19.11	GTO+
10/02/15	Atlas 5-412	AV059	Morelos 3	5300	CC41	4797x35788x26.99	GTO
10/08/15	Atlas 5-401	AV058	NROL 55 (NOSS 3-7)		VA3E	1013x1200x63.43	LEO
10/31/15	Atlas 5-401	AV060	GPS 2F-11	1630	CC41	20426x20486x55	MEO
12/06/15	Atlas 5-401	AV061	Cygnus/OA-4	7492	CC41	230x51.6	LEO/ISS
02/05/16	Atlas 5-401	AV057	GPS 2F-12	1630	CC41	20426x20486x55	MEO
03/23/16	Atlas 5-401	AV064	Cygnus OA-6	~7495	CC41	230x51.6	LEO/ISS[4]
06/24/16	Atlas 5-551	AV063	MUOS 5	6740	CC41	3841x35706x19.1	GTO+
07/28/16	Atlas 5-421	AV065	NROL 61		CC41		GTO [5]
09/08/16	Atlas 5-411	AV067	OSIRIS-REx	1529	CC41		HCO
11/11/16	Atlas 5-401	AV062	WorldView 4	2485	VA3E	610x628x97.96	LEO/S
11/19/16	Atlas 5-541	AV069	GOES-R	5192	CC41	8099x35286x10.6	GTO+
12/18/16	Atlas 5-431	AV071	EchoStar 19	6637	CC41	204x65000x25.44	GTO+
01/21/17	Atlas 5-401	AV066	SBIRS GEO 3	4540	CC41	185x35822x23.29	GTO
03/01/17	Atlas 5-401	AV068	NROL 79 (Intruder?)		VA3E		LEO
04/18/17	Atlas 5-401	AV070	Cygnus OA-7	7227	CC41	230x51.6	LEO/ISS
08/18/17	Atlas 5-401	AV074	TDRS-M	3454	CC41	4640x35787x26.2	GTO+
09/24/17	Atlas 5-541	AV072	NROL 42		VA3E		EEO/M?
10/15/17	Atlas 5-421	AV075	NROL 52		CC41		GTO [5]
01/20/18	Atlas 5-411	AV076	SBIRS GEO 4	4540	CC41	185x35851x16.88	GTO

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(2)Centaur shut down about four seconds early during its second burn, leaving the twin NOSS payloads in an unannounced low transfer orbit. Two weeks after the launch, U.S. Air Force officials reported that liquid hydrogen had leaked through a valve that failed to close properly during the coast phase, leading to a propellant shortage during the second burn. Amateur observers tracked the payloads, in 842 x 1186 km x 63.35 deg orbits, lower than the expected 1,000 x 1,200 km x 63.4 deg. The satellites reportedly would be able to move themselves to operational orbits despite the shortfall.

(3) First RL10C-1 engine flight.

[4] Atlas booster shut down ~5-6 sec early. Centaur burned more than one minute longer than planned to reach orbit. Deorbit missed target. RD-180 Mixture Ratio Control Valve failure caused early LOX depletion.

[5] Probable first next-generation Quasar data relay satellite.

*Site Code:

CC = Cape Canaveral, FL, USA
CC37B = Space Launch Complex 37B: Delta 4
CC41 = Space Launch Complex 41: Atlas 5

VA = Vandenberg AFB, CA, USA
VA3E = Space Launch Complex 3E: Atlas 5
VA6 = Space Launch Complex 6: Delta 4

**Orbit Code:

References

Atlas Launch Systems Mission Planners Guide, Atlas V Addendum, January 1999
Atlas Launch Systems Mission Planners Guide, Rev 9, September 2001
Atlas Launch Systems Mission Planners Guide, Rev 10, December 2004
Atlas V and Delta IV Technical Summary, ULA, June 2013

Last Update: January 20, 2018